Average Total Cost Per Unit Output (1986-1988)

(RBOCs/GTE = 100)

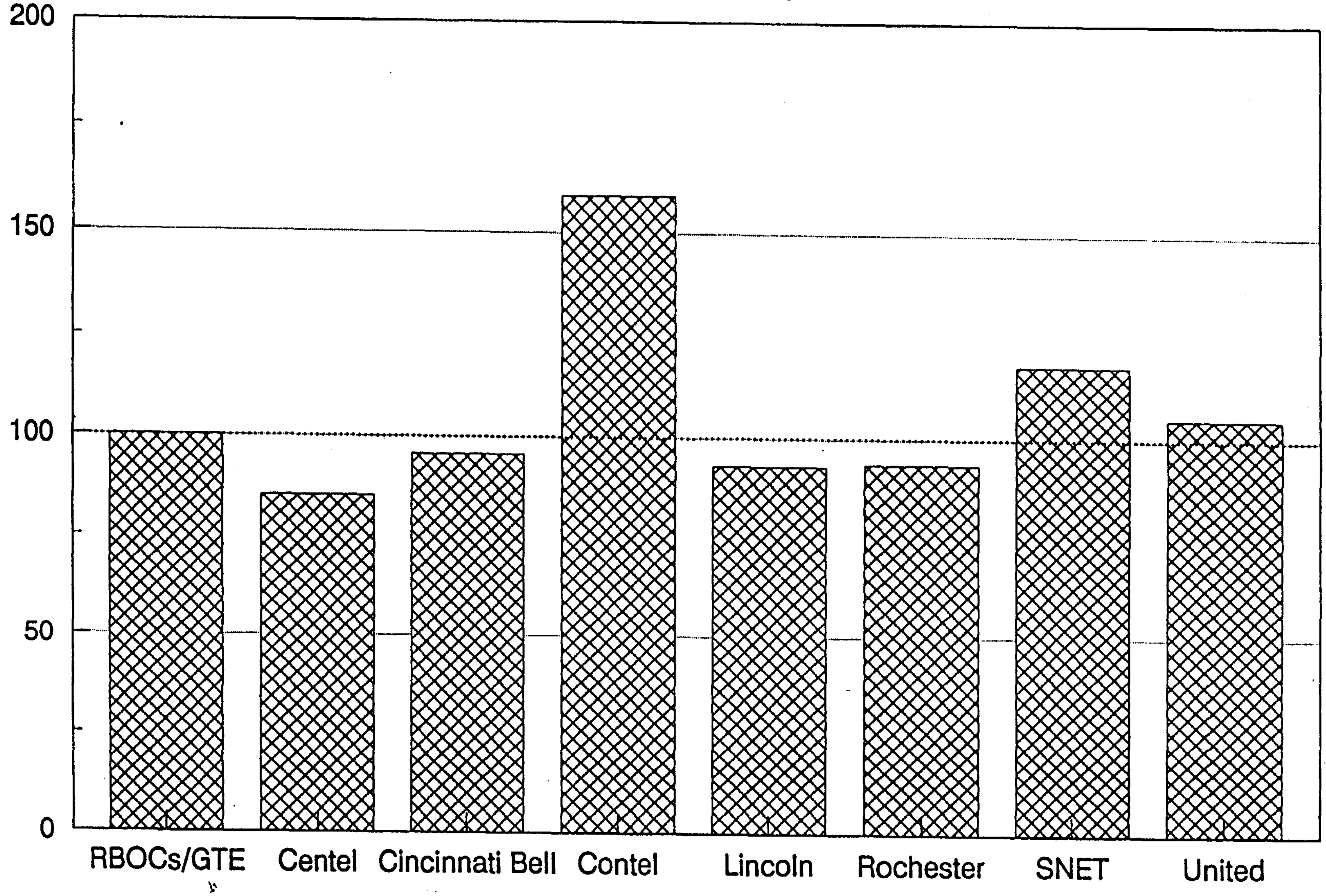

FIGURE 3

3. Time Effects (Fixed)

A fixed effect variable for each successive year in the time period analyzed accounts for variables which may be missing from the model specified. Using this approach averts bias due to the missing variables to the degree that the variables cause equal productivity gains across all companies for a given year. Because the data are pooled (both cross-company and time-series data points are used), including time-specific variables still affords sufficient degrees of freedom to support a robust model. This mechanism accounts for important differences across time periods (such as changes in accounting rules) which are not captured in the other variables, but which may affect measured productivity gains and should be accounted for in the model.[12]

4. Percent Digital/Electronic Equipment

Companies with older-technology switching equipment can improve productivity by installing state-of-the-art digital-switching equipment. Digital switching affords savings by reducing maintenance costs, labor costs, and by promoting operating efficiency. Companies which have already modernized their equipment have less opportunity for productivity improvements by updating switching equipment. As indicated above, the savings that result from deployment of digital equipment are also reflected in the cost level.

Digital share was measured as digital investment divided by total switching investment. This measure is not ideal, since it is affected by past equipment prices and depreciation practices. The measure was chosen because of the availability of data. Data on access lines served by digital switches were not available during the early part of the sample period.

5. Age of Plant

Companies with older average plant can improve productivity by modernization of their plant. Companies that have already modernized have less opportunity to do so. (This is a more general assessment of the same phenomena modeled in No. 4 above.)

6. Growth Rate

Because the cost of serving new demand may differ from that of serving existing demand, a higher growth rate, precipitating a different ratio of existing to new demand, could

[12] Since the model accommodates accounting changes in this indirect manner, it does not yield estimates of absolute productivity gains isolated from any accounting changes. However, the model does yield consistent estimates of relative productivity gains among companies in any given year.

yield a different productivity rate. The growth rate is defined as the percentage increase in the output index.

7. Usage per Access Line

Minutes of use and number of access lines are both outputs. Because the mix of these two outputs may vary, and the productivity associated with each of the outputs also may vary, productivity may differ where the mix is other than the average (where there is heavier or lighter usage per access line).

8. Significance of Candidate Variables

The first three variables (holding-company size, cost level and fixed time effects)[13] were statistically significant, and they are included in the final equation. The remaining variables (digital share, age of plant, growth rate and usage per access line) were not statistically significant, and they are not included in the final equation. As discussed below, the effects of digital share and age of plant may be incorporated in the cost-level variable. The other two variables (growth rate and usage per access line), though plausible determinants of productivity, did not significantly contribute to explaining productivity differences in our sample.

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[13] Fixed time effects actually consist of two regression variables.

III. DATA

A. Data Series and Sources Used

Data for our analyses were drawn primarily from *Statistics of Communications Common Carriers*[14] which reports telephone company financial and operating data taken from annual reports filed by the carriers with the FCC. We collected a large subset of these data. Some of the data were used directly, while others were used to calculate derived variables. Data were actually used for a total of 43 companies, including 21 Bell Operating Companies and 22 independent companies. Annual data were used for 1986[15] to 1989 so we could model annual productivity changes between 1986 and 1987, 1987 and 1988, and 1988 and 1989. In some cases, companies operated for only part of this time period, and then became part of another entity through reorganization.[16] Data for each entity were compiled and analyzed for the years of the entity's operation. Because certain companies had gaps in the data, not all data were used in the analysis. Additionally, some observations were deleted on the basis of extreme, inexplicable data irregularities. All data were converted to real terms, by adjusting for inflation in each year.

Information on the following holding/operating companies was included: Ameritech, Bell Atlantic Corporation, BellSouth Corporation, NYNEX, Pacific Telesis Group, Southwestern Bell Corporation, US West Communications, Cincinnati Bell Telephone Company, Southern New England Telephone Company, Contel Corporation, GTE Corporation, Lincoln Telephone & Telegraph Company, Rochester Telephone Corporation, United Telecommunications, Inc. and Centel Corporation.

There were 37 observations for the year 1986, 39 observations for the year 1987, and 40 observations for the year 1988.

B. Definition of Variables

1. Measures of Productivity

Productivity gain is the excess of the change in output over the change in input factors. In other words, it is a measure of efficiency of production, represented by a change

[14] FCC, *Statistics of Communications Common Carriers*, for years ending 1984 through 1987: Tables 14 and 15; for years ending 1988 through 1989: Tables 2.9 and 2.10.

[15] Data from 1984 were not used directly in the analysis due to data irregularities in that year. Insufficient consistent data were available for 1985 to support analysis for that year.

[16] For example, General Telephone (GTE) of Ohio became part of GTE North in reporting year 1987. Therefore, the partial data series for GTE Ohio is treated as a separate entity in the analysis.

in the number of units that can be produced for a constant cost. Productivity gain is the same as a change in the per-unit cost of production, assuming input costs remain constant. To model productivity gain, the model must isolate the change in per-unit cost which results from any change in productivity rather than resulting from a change in costs of inputs (e.g., a rise in cost of capital). Reductions in input costs do *not* generally reflect more efficient operation, but rather, are a change in cost largely beyond the control of the firm. Therefore, in order to isolate effects of productivity on unit cost from input factor influences on unit cost, we control for changes in input costs by using price indices for the inputs of labor, capital, and material costs for each year in the series, and accounting for the proportion of each expended by the individual companies.

a. Output price index .

Specific data on output price indices were not available. Identifying particular changes in output costs for each of the companies for each year would require extensive research into rate case filings, and was outside the scope of this effort.[17]

b. Output quantity index

Due to the difficulty of obtaining a consistent series of price index data, we could not use deflated revenues as our output quantity index. Data on physical output quantities were used instead.

Gain in Total Factor Productivity can be derived by the difference between proportional changes in quantity and the proportional change attributable to price of inputs, or:

$$\Delta TFP = \frac{\Delta \textit{Quantity Produced}}{\textit{Quantity Produced}} - \frac{\Delta \textit{Quantity Input}}{\textit{Quantity Input}}$$

[17] Crandall and Galst, *op. cit.*, used aggregate data on telephone prices and implicitly assumed that prices of all telephone companies were equal. As previously discussed, that assumption is indefensible and we therefore rejected the Crandall/Galst approach. Crandall/Galst focused primarily on productivity changes over time, and the use of aggregate prices may be appropriate for that purpose. Such use of aggregate prices is, however, wholly inappropriate for analyzing productivity differences among telephone companies.

c. Quantity produced

Quantity data were available on the two primary outputs of each telephone company: (1) access lines, and (2) usage (number of minutes of traffic).[18] Although greater accuracy may be provided by including additional components of output besides these two measures, such information was not readily available. Secondly, although access lines and usage are only two among several elements that constitute total output of the LECs, they are the primary outputs. Finally, the fixed time *effects* variables (previously discussed) control, at least in part, for the effects of other outputs which are not measured directly in the equation.

To measure access lines and usage, the following data were collected: number of access lines and total dial equipment minutes,[19] by year and by company. Dial equipment minutes reflect both access and local calls. They also reflect the more intensive use of switching equipment by certain calls, providing a better measure of actual output represented by processing those calls. The output index used is a weighted average of these two primary outputs.

Estimates of the marginal cost were used to weight the access and usage proportions of the output in this model. The alternative of weighting by revenue share was considered, as revenue (reflecting price) may be appropriate for a competitive market-place.[20] However, in a regulated industry, such as local telephone service, price may not accurately reflect actual marginal cost. Therefore, direct estimates of marginal cost were used for this analysis.

The relative marginal costs of access and usage were estimated in a study by Perl and Falk[21] filed by the United States Telephone Association (USTA) in the price-cap

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[18] The use of only two outputs in this calculation is analogous to using only two quantity variables—access lines and usage—in a cost model.

[19] Both sets of data were taken from the Federal-State Joint Board *Monitoring Report* (CC Docket No. 87-339, January 1991, Tables 4.6A and 4.12A.)

[20] Because revenue reflects prices, the ratio of access and usage prices can be used as a surrogate for the ratio of aggregate marginal costs in the sample. This measure contains the implicit assumption that prices are proportional to marginal costs.

[21] Lewis Perl and Jonathan Falk, *The Use of Econometric Analysis in Estimating Marginal Cost*, (Presented at Bellcore and Bell Canada Industry Forum: San Diego, California), April 6, 1989.

proceeding (CC Docket 87-313) in 1989.[22] The Perl/Falk study estimated marginal costs econometrically on pooled time-series cross-section data collected on 39 companies[23] over 1984 through 1987. The implicit assumption in this measure is that the ratio of access marginal cost to usage marginal cost is the same for all companies and all time periods. Marginal costs are estimated at $300 per access line, and $0.01 per minute usage.

The precise formula used to determine the change in quantity produced is as follows:

$$\frac{(\mathbf{Growth}_{loops} * \mathbf{Number}_{loops} * \mathbf{MC}_{loops}) + (\mathbf{Growth}_{minutes} * \mathbf{Number}_{minutes} * \mathbf{MC}_{minutes})}{(\mathbf{Number}_{loops} * \mathbf{MC}_{loops}) + (\mathbf{Number}_{minutes} * \mathbf{MC}_{minutes})} - 1$$

where;

Growth_{loops}	= Growth rate for telephone loops
Number_{loops}	= Number of telephone loops
MC_{loops}	= Annual Marginal Cost of telephone loop ($300)
$\text{Growth}_{minutes}$	= Growth rate for minutes of usage
$\text{Number}_{minutes}$	= Number of minutes of usage
$\text{MC}_{minutes}$	= Marginal Cost of minute of usage ($0.01); or $10,000 per million minutes of usage

This formula provides a measure of the growth or shrinkage in output.

d. Quantity of input

Changes in input quantities are calculated by examining the *real* change in input expenditures (obtained by adjusting expenditures for shifts in price that serve to change expenditure but not in quantity). Subtracting the changes in price of inputs removes effects that are attributable to shifts in factor prices, rather than increased input quantity. Expenditures for each of the three input factors—capital, labor and material—are adjusted for price changes and multiplied by the respective contribution to overall input expenditures. The summation of the total reflects growth (or shrinkage) in total input quantity which must be subtracted from the growth in total output quantity to reveal changes in efficiency. The precise formula used to measure changes in quantity of input factors is as follows.

[22] "Analysis of AT&T's Comparison of Interstate Access Charges Under Incentive Regulation and Rate of Return Regulation," prepared by NERA, July 24, 1989.

[23] 24 Bell and 15 non-Bell companies.

$$(\mathbf{Growth}_{cap\ exp} - \mathbf{Growth}_{cap\ price}) * (\mathbf{Cost}_{cap}/\mathbf{Cost}_{tot})$$

$$+$$

$$(\mathbf{Growth}_{labor} - \mathbf{Growth}_{labor\ price}) * (\mathbf{Cost}_{labor}/\mathbf{Cost}_{tot})$$

$$+$$

$$(\mathbf{Growth}_{mat\ exp} - \mathbf{Growth}_{mat\ price}) * (\mathbf{Cost}_{mat}/\mathbf{Cost}_{tot})$$

where;

Growthcap_{exp}	= Growth rate for capital expense
$\text{Growth}_{cap\ price}$	= Growth rate for capital price
Cost_{cap}	= Capital expense
Cost_{tot}	= Total cost
Growth_{labor}	= Growth rate for labor expense
$\text{Growth}_{labor\ price}$	= Growth rate for labor price
Cost_{labor}	= Labor expense
$\text{Growth}_{mat\ exp}$	= Growth rate for material expense
$\text{Growth}_{mat\ price}$	= Growth rate for material price
Cost_{mat}	= Material expense

2. Sources for Measures of Input

The exact components of the variables used in the formula for changes in input quantity are discussed below:

a. Cost indices

1) Material expenses

Total operating expenses (as reported) less total compensation[24] less total depreciation and amortization expense. (Taxes are not part of materials expense and are not included in operating expenses).

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[24] Compensation data were taken directly from company annual reports provided by the FCC.

2) Capital costs

Capital costs equal capital stock multiplied by the price of capital. Capital stock was calculated as follows: the prior year's capital stock[25] was multiplied by the annual change in the TPI and one minus the predicted depreciation rate. Added to this result was new investment, yielding a running total of the replacement cost of the capital stock. New investment is the change in plant in service plus retirements. Retirements were estimated as depreciation and amortization expense less the annual change in cumulative depreciation and amortization.

3) Labor expenses

Labor expenses were taken directly from company annual reports filed with the FCC.

4) Total cost

The formula used to calculate total cost was: labor expenses plus material expenses plus capital costs. Total costs also equal total operating expenses minus total depreciation and amortization expense plus capital expenses.

b. Price indices

1) Price of labor

The index was based on state-specific, average annual wage in the transportation, communications and public utilities industries.[26]

2) Price of materials

The fixed-weighted price index for gross national product (GNP-PI) was used.[27]

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[25] For the initial year, the previous year's capital stock is a deflated value of the total plant in service, or the economic value. The deflator equals the following:

$$\alpha_t = \frac{\sum_{j=0}^{20} (1+\Delta)^{t-j}(1-\delta)^j}{\sum_{j=0}^{20} (1+\Delta)^{t-j} TPI_{t-j}}$$

where Δ equals the company's average annual growth in loops and δ equals the company-specific depreciation rate.

[26] Data were downloaded from Data Resources, Inc.

[27] Data were downloaded from Data Resources, Inc.

3) Price of capital

The price of capital includes the sum of the risk-free rate plus a risk premium. The Treasury Bill rate[28] was used to estimate the risk-free rate. The risk premium was estimated at 3 percent, which is roughly consistent with the Commission's calculated cost of capital. To this sum is added the predicted depreciation rate[29] and the predicted tax rate,[30] less the annual growth in Total Plant Index (TPI).

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[28] The 10-year composite rate for U.S. Treasury notes and bonds. Figures were taken from *Federal Reserve Bulletin* (Board of Governors of the Federal Reserve System, Washington, D.C., December 1986, July 1990, October 1990, Table 1.35, p. A24.).

[29] Company-specific average, over all years, of the reported depreciation expenses divided by net plant. Net plant equals the reported total plant less total depreciation and amortization.

[30] Predicted in a similar manner to the depreciation rate, but accounting for tax reforms which occurred after 1986. Predicted tax rate was based on a regression of the reported tax expense over the net plant on company indicator variables plus a 1987 and post-1987 indicator to account for the declining tax rates.

IV. STATISTICAL RESULTS

Several of the candidate independent variables proved to be insignificant in the regression analyses, and were excluded from the final models. In particular: the share of digital equipment, the age of plant, usage per access line, and growth rate were all were excluded. Notwithstanding their exclusion, digital share and age of plant do enter the equation indirectly, since the savings that result from deploying state-of-the-art equipment are reflected in the cost level.

A. Final Model: Productivity as a Function of Holding Company Size, Cost Level and Operating Year

The equation which best explained the changes in productivity is as follows:

$$\Delta TFP = -0.1236 + 17.48x_{cost\ index} + 0.007821\ \mathit{ln}x_{hcsize} - 0.0900x_{1987} - 0.0469x_{1988}$$

where;

ΔTFP	=	Gain in Total Factor Productivity
$x_{cost\ index}$	=	Estimate of Cost Level (total cost per unit output); Total Cost/(Marginal Cost$_{lines}$*Q$_{lines}$ + Marginal Cost$_{usage}$*Q$_{usage}$)
$\mathit{ln}x_{hcsize}$	=	Log of size of the holding company (measured in access lines)
x_{1987}	=	Fixed effect for the year 1987
x_{1988}	=	Fixed effect for the year 1988

1. Statistical Fit

r^2: 0.61

r^2_{ADJ}: 0.59

MSE_{root}: 0.0315

F Value: 43

t Statistics:

$x_{cost\ index}$:	1.8
$\mathit{ln}x_{hcsize}$:	2.8
x_{1987}:	-12.3
x_{1988}:	-6.5

All the estimated coefficients are significantly greater than or less than zero at the 5-percent level (one-tailed test).

2. Interpretation of Results

The statistical relationship developed in the model indicates that the primary determinants of productivity gains are the size of the holding company and the cost level per unit of output. The size of the holding company had a large effect on productivity gains, encompassing the effects of any economies of scale which may have been achieved. For example, the model indicates that, if Company A is twice the size of Company B, Company A's productivity change will exceed that of Company B's by 0.54 percent per year.[31] The profound effect of the cost index is intuitive because a firm which is operating at above average costs to start with would be most easily able to experience productivity gains by cutting costs and increasing efficiency of operations. For example, if Company A has an average cost level for producing output, and Company B's cost level is 10 percent below average, Company A's productivity change can be predicted to exceed that of Company B by 0.24 percent per year. This effect tends over time to reduce differences in productivity gains among companies, but the effect is very slow. The expected annual difference in productivity gain is only 2.4 percent of the original difference in unit costs. Nevertheless, expected annual productivity gains are *substantially* less for low-cost companies, such as Centel, than for higher-cost companies.

3. Individual Company Forecasts

Using the model developed, it is possible to forecast what the expected productivity gains for each firm examined will be. The forecast values reflect the latest specific effects—the 1988 time-specific effect, 1988 cost level and the 1988 holding company size. Table 1 reflects the forecasted total factor productivity changes relative to the composite Bell/GTE average:[32]

[31] This is calculated as the product of the estimated coefficient (0.007821) and *ln* 2 (0.6931).

[32] Composite average is weighted by revenues of individual companies contributing to the average.

TABLE 1 TFP CHANGES	
Holding Company	TFP Forecasted Change Relative to Bell/GTE Average
Bell/GTE Average	0.0%
Cincinnati Bell	-2.3%
Southern New England Telephone	-1.2%
Contel	-0.8%
Lincoln	-3.5%
Rochester	-2.8%
United	-1.0%
Centel	-1.5%

Figure 4 provides a graphical display of the difference in forecasted change in total factor productivity by LECs other than Bell or GTE from the mean change in total factor productivity by the Bell/GTE composite average for 1986 through 1988. The results indicate that the non-Bell/GTE LECs are all likely to experience less productivity growth than will the Bell/GTE average.

The ordering of our forecasts is generally consistent with the decisions that carriers have actually made with regard to price caps. Companies whose expected productivity gains are within 1.2 percent per year of the BOC/GTE average (United and SNET) have elected price caps.[33] This also applies to Contel, though price caps are mandatory for Contel as a result of its acquisition by GTE. The expected productivity gains of Centel, Cincinnati Bell and Lincoln are all at least 1.5 percent per year less than the BOC/GTE average. These companies have declined to go under price caps. The one anomaly in this analysis is Rochester, which elected to go under price caps even though its expected productivity gains are 2.8 percent per year less than the BOC/GTE average.

[33] These companies may or may not profit as a result of their decision to elect price caps. In any event, our analysis suggests that they are unlikely to do as well under price caps as the larger LECs.

Forecasted Annual Total Factor Productivity Change Relative to RBOCs/GTE

(Percent)

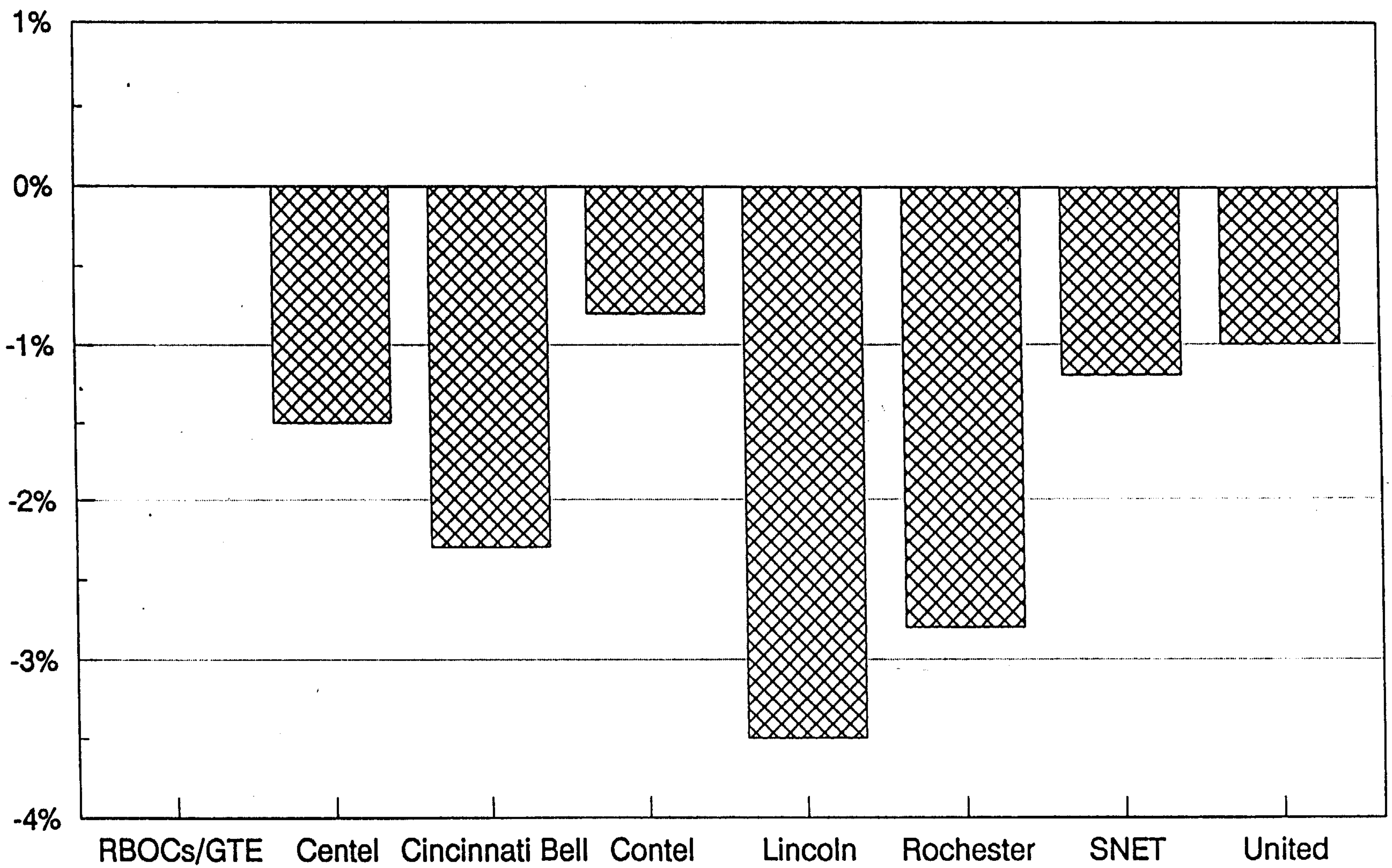

FIGURE 4

V. IMPLICATIONS FOR PRICE CAPS

The quantitative analyses of this study indicate that the size and level of costs of a telephone company cause statistically significant variations in expected productivity gains. The method of rate regulation should not penalize companies because of their relatively small size or because of their past successful efforts to reduce their costs, such as through aggressive implementation of digital technologies.

In the context of price-caps plans, the FCC and state commissions should adopt different productivity adjustments for different carriers, or at least for several different groupings of carriers. Smaller, lower-cost carriers should have a substantially lower productivity adjustment than the level applied to the BOCs and GTE. This study estimates a reasonable productivity adjustment for Centel that is 1.5 percentage points below that of the BOCs and GTE.

A single productivity adjustment applicable to all carriers fails to maximize the effectiveness and reasonableness of the price-caps method of rate regulation. The FCC has allowed (and state commissions may allow) carriers such as Centel to choose to have their rates regulated by a price-caps plan where the productivity adjustment was developed from analysis of the BOCs and GTE or an industry average. The statistical analysis of this study indicates that such carriers would likely earn unreasonably low returns under such a plan. Smaller, lower-cost carriers may reasonably choose to be subject to the traditional method of rate regulation instead of such a price-cap plan.

Another method of rate regulation ("shared earnings" or "banded rate of return" plans) establishes a zone of earnings that a carrier can retain without partial or full refunds to ratepayers. These plans should reflect the fact that productivity gains can be more easily achieved by larger, higher-cost carriers than by smaller, lower-cost carriers. A level of productivity gains yielding, for example, earnings 200 basis points above some prescribed level may represent above-average efforts by a larger, higher-cost carrier. But, the same level of productivity gains and earnings would correspond to truly extraordinary efforts by a smaller, lower-cost carrier. In order to match rewards to accomplishments, the zone of potential retained earnings for smaller, lower-cost carriers should be higher (more potential for retained earnings) than the zone for larger, higher-cost carriers.

Finally, this study also has important implications for cost-plus methods of rate regulation. Traditional rate-base/rate-of-return regulation incorporates the concern about reasonable productivity gains in determining whether particular investments and expenses are "imprudent" or not "used and useful," or whether overall cost levels are "excessive." In these determinations, regulators frequently use other carriers' performance as bench marks. This study finds that a shortfall in the productivity gains by a mid-sized, lower-cost carrier when compared against larger, higher-cost carriers can reasonably be expected in light of their differing operating conditions. If such a shortfall appears, it should not be taken as evidence that the smaller, lower-cost carrier is inefficient or poorly managed.

In the Matter of	)	
	)	
Price Cap Performance Review for Local Exchange Carriers	)	CC Docket No. 94-1
	)	
	)	
Access Charge Reform	)	CC Docket No. 96-262

COMMENTS OF THE INDEPENDENT TELEPHONE AND TELECOMMUNICATIONS ALLIANCE

January 7, 2000

EXHIBIT B

STRATEGIC
POLICY
RESEARCH

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One Size Does Not Fit All: The Inadequacy of a Single X-Factor for All Price-Cap Companies

Jeffrey H Rohlfs
Kirsten M. Pehrsson[1]

The Federal Communications Commission (FCC), in its *Fourth Report and Order*,[2] decided to use a single X-Factor for all price-cap local exchange carriers (LECs). In this paper, we argue that using a single X-Factor is unfair and inequitable. We specifically respond to the FCC's evidence justifying a single X-Factor. We also present specific evidence that the FCC's X-Factor is inappropriate for Cincinnati Bell.

Interim Plan Versus New Plan

Under the FCC's interim price-cap plan, LECs had a choice of X-Factors. LECs which chose the highest X-Factor were exempt from any sharing of earnings. LECs which chose a lower X-Factor incurred obligations to share earnings above certain prespecified levels.

A drawback to this approach is that sharing dilutes the incentives of LECs to improve efficiency. In general, one would expect LECs that operate under sharing regimes to be less efficient in the long run than similar companies operating under pure price caps. For this reason, the FCC abandoned the interim approach in favor of a pure price-cap plan.

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2 FCC, In the Matter of Price Cap Performance Review for Local Exchange Carriers, Access Charge Reform, *Fourth Report and Order in CC Docket No. 94-1 and Second Report and Order in CC Docket No. 96-262*, CC Docket No. 94-1 and CC Docket No. 96-262, adopted May 7, 1997, released May 21, 1997.

We certainly do not criticize the FCC's decision to eliminate sharing. Nevertheless, the interim plan did have the advantage of distinguishing among LECs. It did not envision that one size of price-cap plan fits all companies.

A variform approach to price caps is desirable, because price-cap LECs are so diverse. At one extreme are urban companies, such as Cincinnati Bell and Lincoln. At the other extreme is Citizens, which serves entirely rural communities. All these companies are very different from the Regional Bell Operating Companies (RBOCs). Each RBOC is 10 times as large as the smaller companies and each serves diverse areas, including urban and rural communities. Conceivably, the RBOCs are sufficiently homogeneous that a single X-Factor is appropriate for all of them. However, it would be an amazing coincidence if that same X-Factor were also appropriate for Cincinnati Bell and Lincoln, as well as Citizens. We demonstrate in this paper that, for Cincinnati Bell at least, there is no such coincidence.

The FCC's new price-cap plan should take account of differences among price-cap LECs. It need not give companies a choice of X-Factors (in exchange for differential sharing obligations). It could instead have different X-Factors for companies with different prospects for productivity growth. We discuss below how multiple X-Factors can be used without diluting efficiency incentives.

Response to the FCC's Evidence

In the *Fourth Report and Order*, the FCC adduces a variety of evidence to justify its decision to use a single X-Factor. In this section, we respond to that evidence.

Court Cases

The FCC cites court cases to demonstrate that using a single cost standard is not "inherently" unreasonable.[3] To be sure, a single standard might be the only practical alternative under some circumstances; *e.g.*, if the regulatory body has minimal staff and/or cost data are lacking. However, these considerations obviously do not apply to the FCC.

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[3] *Ibid.*, ¶ 160.

Indeed, the FCC staff has already developed a computer model of productivity growth. The model that the FCC has disclosed is populated with RBOC data. However, the same model could easily have been populated with data from other LECs.[4] We were able to populate the model with Cincinnati Bell data in a few days' time. The FCC could certainly have done likewise.[5] One would certainly have expected that members of the Commission staff would already have populated the model with data from LECs other than RBOCs in order to observe the results. Yet, no results of applying the model to non-RBOC data were discussed in the *Fourth Report and Order*.

Reference to Corrected Norsworthy Model

In justifying the use of a single X-Factor, the FCC does not refer to its own model. Instead, it refers to the Norsworthy model, as corrected by Christensen.[6] The corrected Norsworthy model yields estimates of productivity growth between 2.9 percent per year and 3.1 percent per year. It is hard to see how these estimates can possibly justify setting an X-Factor of 6.5 percent per year for all price-cap LECs.

No Basis for Distinction

The FCC observes, "Furthermore, the record contains no convincing proposals that would allow us readily to identify any characteristics by which we could assign individual X-Factors to different price cap carriers, so there could be multiple 'no sharing' X-Factors."[7] This statement seems to imply that the FCC, like a court of law, can consider only evidence that is submitted by the adversaries in the case. In reality, the FCC has already ranged far afield of the evidence submitted by the parties. Indeed, the whole new price-cap plan is based on productivity analysis conducted by the FCC Staff — analysis which differs substantially from any that has been submitted by the parties.

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4 Data from some companies will undoubtedly be incomplete and/or have data problems. Nevertheless, sufficient data are probably available in every case to draw valid inferences about differences in productivity.

5 Moreover, our task was made more difficult, because the Commission altered its spreadsheet (159chrts.xls) to substitute values for the underlying formulae. We therefore had to take time to reconstruct the formulae. The Commission can use its unaltered spreadsheets and does not have to do such reconstruction.

6 *Fourth Report and Order*, ¶ 135.

7 *Ibid.*, ¶ 158.

It is a logical next step to use the same model to investigate the efficacy of different X-Factors for non-mandatory price-cap LECs.

There are several ways that the FCC might distinguish among LECs and have different X-Factors. The simplest possibility is to have one X-Factor for the mandatory price-cap LECs and a different X-Factor for other price-cap LECs. This possibility would be appropriate if the FCC Model indicated that non-mandatory companies are homogeneous but different from the mandatory companies. That outcome does not, however, seem likely. Two other possibilities are suggested by a study that we conducted in 1991 and filed at the FCC. According to that study:

- Companies that already have low unit costs tend to have slower productivity growth.[8] If the FCC model supports this finding, there should be a lower X-Factor for companies that already have low unit costs.
- LECs whose holding companies are smaller tend to have slower productivity growth. If the FCC model supports this finding, there should be a lower X-Factor for small holding companies.[9]

The FCC should test these (and other) possibilities with its own cost model. If differences in productivity growth are not related to any of these factors, the FCC would then have an evidentiary basis to support a single X-Factor. We believe that, on the contrary, such analysis would provide an evidentiary basis for different X-Factors for different companies.[10] Conceivably, there could be a different X-Factor for each company. However, rough justice (and administrative simplicity) could probably be achieved by having relatively few X-Factors for companies that fall into various categories.

8 We denoted this finding as the Roseanne Barr effect. That is, it is easier for Roseanne Barr to lose weight than for Arnold Schwarzenegger.

9 J. Rohlfs, "Differences in Productivity Gains Among Telephone Companies," prepared for CENTEL, September 3, 1991.

10 We hasten to add that do not necessarily endorse the FCC's methods for estimating productivity. Nevertheless, the FCC should use a consistent analytical approach. Arbitrarily combining parts of one model (*e.g.*, the Staff Model) with parts of other inconsistent models (*e.g.*, the Norsworthy model, as corrected by Christensen) cannot lead to rational policies.

Gaming of Multiple X-Factors

The FCC expresses concern that multiple X-Factors could be gamed by LECs.[11] This concern is certainly understandable. However, gaming would likely be a problem only if the multiple X-Factors are constructed so as to reward poor performance. There would be no problem of gaming if the multiple X-Factors were based on exogenous variables. Furthermore, X-Factors that are lower for low-cost companies encourage good performance. They thereby enhance the efficiency incentives under price caps.

Choice of X-Factors

The FCC observes that virtually all the mandatory price-cap LECs have opted for the higher X-Factor during at least part of the interim price-cap period.[12] However, this finding obviously cannot justify a single X-Factor for *non-mandatory* price-cap LECs. In reality, the elections of non-mandatory price-cap LECs indicate considerably greater heterogeneity. For example, Southern New England Telephone Company elected the lower X-Factor for both years of the interim plan. Alltel has indicated its lower prospects for productivity growth by declining to elect price caps at all. Until this year, Cincinnati Bell did likewise. Furthermore, Cincinnati Bell chose price-caps, in part, to enjoy the greater pricing flexibility that it needs to meet competition — not because it expects productivity growth in excess of 6.5 percent per year. A price-cap regime with multiple X-Factors would have the advantage of encouraging LECs with lower prospects for productivity growth to elect price caps. If the X-Factors are properly crafted, the outcome could be lower prices for consumers, as well as benefits to the firms.

In any event, one must be cautious in using elections of X-Factors to draw inferences about future productivity growth for the following reason:

> Price-caps are generally conceived as a win-win policy. That is, the productivity gains resulting from price caps are supposed to be shared by the company and its customers. The company's gains are manifest in earnings above its cost of capital. These earnings are expected to grow over the period of a price-cap plan. They decline, but not necessarily to zero, when a new price-cap plan begins.

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11 *Fourth Report and Order*, ¶ 159.

12 *Ibid.*, ¶ 157.

A company that has been under price-caps may elect a higher X-Factor to postpone sharing productivity gains that it made in the past. Such an election does not necessarily indicate that the company expects rapid productivity growth in the future.

Analysis of Cincinnati Bell's Productivity

In this section, we present estimates of Cincinnati Bell's productivity growth. The estimates are based primarily on the productivity model developed by the FCC Staff. We did, however, need to make adjustments with respect to unregulated costs and interstate special access.

Unregulated Costs

The productivity model developed by the FCC Staff does not include outputs associated with unregulated activities. Formally, this omission is manifest in the exclusion of Miscellaneous Revenues, which include revenues from unregulated activities.

As a matter of theory, a productivity model that excludes the outputs of unregulated activities should also exclude the inputs used to produce them. Otherwise, output growth and input growth are inconsistent and cannot be compared to estimate total factor productivity. Nevertheless, the FCC Staff Model does not exclude the inputs used in unregulated activities. Failure to exclude such inputs is theoretically suspect. Nevertheless, that methodology may be reasonable for estimating RBOC productivity growth, since unregulated activities constitute only a small part of RBOC output.

That methodology is not, however, reasonable for Cincinnati Bell. Unregulated activities are a larger fraction of Cincinnati Bell's output than of RBOC output.[13] Furthermore, Cincinnati Bell's unregulated activities have followed quite a different pattern than regulated activities; so regulated activities are not an adequate proxy for unregulated activities.[14]

For this reason, we exclude unregulated inputs from our analysis. Our estimates of unregulated inputs are based on annual ARMIS reports. The detailed procedures are described in the tables in the Appendix.

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[13] An important reason for this difference is that Cincinnati Bell is not subject to all the separate-subsidiary requirements that the RBOCs are subject to.

[14] In particular, unregulated activities have declined irregularly over the past several years, while regulated activities have grown fairly steadily.

Special Access

Cincinnati Bell's data on number of special-access lines have large year-to-year fluctuations. We do not understand the reasons for those fluctuations. In any event, the data on number of special-access lines are probably not an adequate quantity index for output for special access. We therefore, exclude special-access from our analysis.

For comparability, we also exclude special access from the FCC's analysis of RBOC productivity. In our analysis, we are not especially concerned with the absolute levels of productivity growth. Rather, we examine the difference in productivity growth between RBOCs and Cincinnati Bell.

Results

Table 1 shows results of applying the FCC's methodology, modified as described above, to Cincinnati Bell data. The table shows that Cincinnati Bell's average price/productivity differential from 1990 to 1995 was 1.8 percent per year. The average from 1991 to 1995 was 2.8 percent per year.

The RBOC results, adjusted for special access, are shown in Table 2. The RBOC price/productivity differential, excluding special access, averaged 4.9 percent per year from 1990 to 1995 and 4.3 percent from 1991 to 1995.

The difference between the Cincinnati Bell and RBOC results is enormous. It amounted to 3.1 percent per year from 1990 to 1995 and 1.5 percent per year from 1991 to 1995. These data strongly suggest that Cincinnati Bell has lower prospects for productivity growth than do RBOCs. This finding is consistent with past studies, which also demonstrated that Cincinnati Bell's productivity growth is slower than that of larger LECs.[15]

Efficiency of Cincinnati Bell

The lower productivity growth does not indicate that Cincinnati Bell is less efficient than the RBOCs. On the contrary, Cincinnati Bell is a low-cost company. In particular, Cincinnati Bell's price for interstate switched access was only $0.020 per minute in 1995. This can be compared to

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[15] *See* J. Rohlfs, "Incentive Regulation and Estimates of Productivity," prepared for Cincinnati Bell Telephone Company (Attachment I), June 9, 1989. *See* also Rohlfs (1991).

the average RBOC price of $0.028 per minute. The Cincinnati Bell price was almost 40 percent lower than the RBOC price. These price differences reflect differences in unit costs allocated to the interstate jurisdiction. As discussed above, further productivity gains are more difficult for companies that are already efficient.

Conclusions

Our productivity analysis demonstrates that Cincinnati Bell has had slower productivity growth than the RBOCs. The slow growth does not indicate poor performance by Cincinnati Bell. On the contrary, Cincinnati Bell has lower unit costs than the RBOCs. It is difficult for Cincinnati Bell (or any firm) to improve its good productivity at the same rate that higher-cost firms can improve their productivity.

More generally, one size of price-cap plan does not fit all LECs. It is unfair and inequitable for the FCC to use the same X-Factor for firms that have substantially different prospects for productivity growth. Multiple X-Factors can be developed and used without significant administrative burdens and without allowing gaming by LECs.